

SIMULATION-BASED REVALIDATION MODEL COURSE TO DEMONSTRATE SEAFARERS' COMPETENCE FOR DECK OFFICERS DISCIPLINE

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Abstract

In accordance with Part A, Chapter I, Section I/11 Revalidation of certificates of STCW Code, continued professional competence shall be established, among others, successfully completing an approved training course or courses. The main objective of this paper is to design the contents of the model course using simulation technology to assessment of seafarers' competence in accordance with the provisions of STCW Code for existing marines who need upgrade their professional maritime certificates in accordance also with the Standards governing the use of simulators, Reg I/12 of 2010 STCW Code, which will allow a greater cohesion, unification and harmonisation between maritime institutions.

This paper is structured into following sections: Section 1 identifies current national refresher and updating programmes courses; Section 2 provides some general information of the application of simulation technology; Section 3 explains the design and development of the revalidation model course structure and finally Section 4 remarks some conclusions of the research.

Keywords

Maritime Education and Training, Simulation, STCW Code, Revalidation of certificates

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1. INTRODUCTION

International Maritime Organization's (IMO) international convention on Standards of Training, Certification and Watch-keeping for seafarers (STCW) [1] was ratified by all maritime nations. Today, IMO has advised/encouraged all contracting governments/interested parties to review and, as necessary, to revise their crew academic/vocational competency described in STCW. Furthermore, European Maritime Safety Agency (EMSA) started regular assessment process providing quality improvement in the MET institutions throughout EU members, candidate countries and others.

The main objective of this research is to design the contents of a model course using simulation technology to assessment seafarers' competence in accordance with the provisions of STCW Code for existing marines who need upgrade their professional maritime certificates in accordance also with the Standards governing the use of simulators, Reg I/12 of 2010 STCW Code (deck officers discipline).

The specific research objectives are:

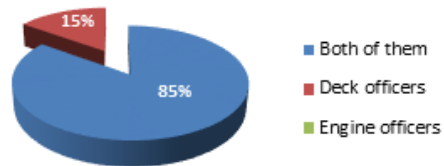
- Develop a common academic programme using simulation methodology to review and demonstrate competence to license the revalidation marine certification. This common course will also allow a greater cohesion between international and local requirements providing a higher quality.
- Promote the implementation, development, harmonisation and unification of the maritime programme contents considering international standards for training of seafarers.
- Establish a quality assurance and control system.
- Use of the existing knowledge and experience of maritime education and training institutions using simulation training to achieve experience and to gain corresponding skills.
- Prepare a publication, as a guidance tool, of the model contents (theoretical and practical) to demonstrate marine certification competence.

2. CURRENT NATIONAL REFRESHER COURSES

Assessment and examination methods and practices vary from country to country. This first section will deal with basic investigations to identify current national refresher and updating programmes courses. To obtain this information, an email was sent to all IAMU members but, since these programs are usually written in national languages, we only received 7 answers. After that, they were asked to answer a simplified questionnaire with 14 questions, and we obtained 22 answers (39% of the IAMU memberships). 3 of the 22 institutions don't have a revalidation program for Certificate of Competence (CoC).

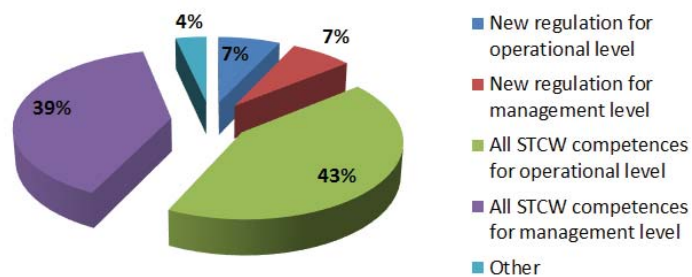
From the answers obtained, following figures (see figures 1-4) draw main results.

Figure 1 - Question 1: Which kind of course do you assess?



As can be seen in Figure 1, almost all institutions assess both courses, deck and engine officers, and none of them only engine officers discipline.

Figure 2 - Question 2: Which kind of topics do you assess?



From figure 2 we can observe that there are some differences with the kind of topics that the revalidations courses assess.

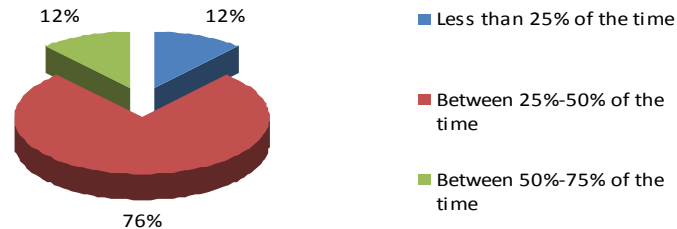
From 19 institutions analysed, 17 uses simulators in the CoC revalidation course and 8 of them use all type of simulator (see Table 1).

Table 1 - Type of simulator used by institutions

Navigational simulator	17
GMDSS simulator	13
Cargo handling simulator	11
Engine room simulator	12

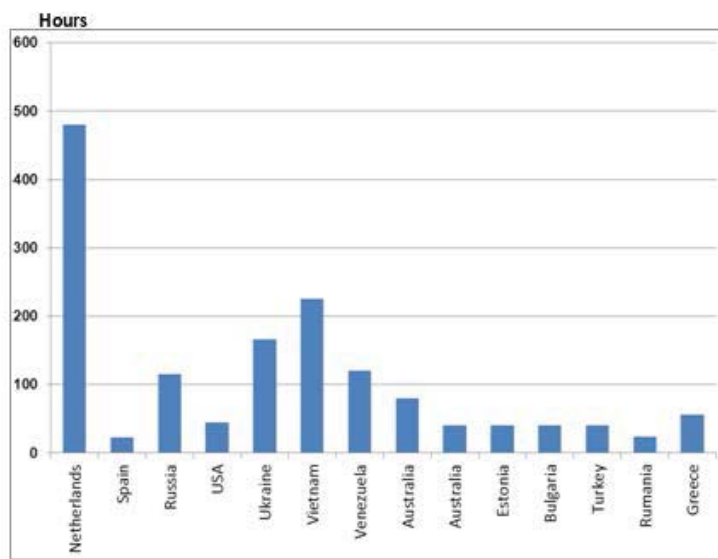
Considering the time of the use of simulation on the revalidation courses analysed, figure 3 is obtained and more than 75% use simulation on the revalidation course between 25% and 50% of the time.

Figure 3 - Question 3: How much time do you devote to the use of simulators on the revalidation course?



Also, course duration varies considerably from country to country (see figure 4) and depends on government requirements, kind of basic education and requirements regarding duration of the sea stage.

Figure 4. Question 4: What is the duration of the course?



3. APPLICATION OF SIMULATION TECHNOLOGY

This section identifies characteristics of maritime simulators (types and classification), simulator training and general conditions of the simulator training. At the end of this section, an analysis of which maritime competences can be assessed using simulation technology according chapter II, part A of STCW Code 95/2010 is carried out.

The progress in the electronics industry has strongly influenced the development and application of simulators for specific marine related training objectives. More and

different types of simulators are becoming available to a wider group of users as a basis for the quality training requirement.

Within IMO and Inter-sessional Simulator Working Group (ISWG) was established in order to organize and structure simulator related matters for inclusion in the STCW revision. One definition adopted by ISWG [2] reads:

Simulation is a realistic imitation, in real time, of any ship handling, radar and navigation, propulsion, cargo/ballast or other ship-system incorporating an interface suitable for interactive use by the trainee or candidate either within or outside of the operating environment, and complying with the performance standards prescribed in the relevant parts of this section of the STCW code.

3.1. TYPES OF MARITIME SIMULATORS

The fact that a simulation system represents a powerful teaching tool, which can lead to more effective training outcomes as well as a more efficient use of available teaching time, adds to the increased popularity of simulation equipment. Additionally, the assessment of competence of seafaring skills can be performed in a lifelike simulation centre, which resembles as closely as possible the real system called “ship”. As IMO is seeing the necessity to assess competence rather than knowledge in order to improve shipping safety and simulators are offering possibilities for such, it seems without doubt that much more emphasis will be placed on marine simulation in the years to come.

The radar and ship handling simulators are the most well-known and wide spread, but it is quite surprising to see which other types of activities and equipment have become models for a maritime training simulator system and up to date have been developed and installed:

- navigation equipment trainer (NAV)
- communication procedures/GMDSS equipment trainer (COM)
- radar simulator (RAD)
- radar and navigation simulator (NAV/RAD)
- ship handling simulator with/without motion platform/image generation (SHIP)
- fisheries simulator
- inland waterways simulator
- dynamic positioning simulator
- crane handling simulator (CRA)
- vessel traffic management simulator (VTS)
- search and rescue management trainer (SAR)
- oil spill management trainer (SPILL)
- propulsion plant trainer
- team generation plant trainer
- electrical power plant trainer
- refrigeration plant trainer

- cargo handling trainer (CAR)
- ballast control trainer (BAL)
- dredging ship trainer
- offshore process simulator
- drilling technology simulator

Note: names in brackets and bold, are assigned to refer to each particular type of simulator later on.

This list is not intended to be all-inclusive. As technology advances, new systems, both from the shipping industry as well as within the simulation techniques, are being created with a certain regularity.

3.2. TYPES OF SIMULATOR TRAINING

A simulator is a training tool, which has to be integrated into a total training programme. This means that a simulator can and should be used for training of normal and emergency operations. This is possible without endangering people or environment, even if the training actions are not performed properly. Once the quality of the training efforts has been assured as indicated above, it will become necessary to distinguish the type of training that is to be performed, especially related to the seafaring profession. The training can be done in different modes and at various levels. If the training programme is of a modular design the specific training requirements can be matched with each module.

Investigation into the design of training scenarios will offer a possible division of training into five basic types described as follows:

- **Team training:** a team is a group in which decisions are made based on evaluation of information in order to execute the necessary operation. Team training is carried out to establish or to improve a team as a means to lead to decision training.
- **Operator training:** operator training is required in order to train a person in proper equipment operation procedures. Ships are equipment prone so operator training is highly relevant in the maritime profession.
- **Decision making training:** decision making training is done in order to train persons in making the right decisions, based on evaluation of a given situation and to carry out the necessary action to reach a defined goal. In many situations the decision maker can communicate directly with the equipment rather than through an operator. The decision maker thus becomes an operator.
- **Procedure training:** procedure training takes place in order to train a group of persons the correct execution of a specific procedure.
- **Maintenance training:** this is done in order to train individuals in either technical or condition control maintenance.

Without proper identification of the type of training which is to be performed it will be more difficult to reach a quality composition of the training in general or training by means of simulators in particular.

3.3. ASSESSMENT OF SIMULATOR TRAINING

It is common practice that all training and educational efforts will include a stage of assessment and evaluation to monitor if the training objectives have been met. Over the years, various systems for evaluation of education and training have been developed and applied. Usually every teaching or training institution will be involved in evaluation and assessment. However to what extent and by which methods is an area which has been argued by educationalists in the past and will continue to be open for discussion [3]. With the revised STCW 95 the evaluation of skills has been indicated as the assessment of competences and this is presently a major effort of the maritime training establishments.

The method used to assess will depend on the training tool, which is applied. Furthermore the actual skill, which is supposed to be acquired, and which should be evaluated will differ and range from very elementary, like making a certain knot, to very complex, like piloting a vessel. In competence based training the evaluation can preferably be done with or on the training tool, which has been used. In the case of acquiring complex skills this could mean on board a vessel or on the tool, which was used to represent the vessel, such as a simulator.

Although not done in a universally structured manner as with the assessment of other training systems, some attempts are being made by training providers to assess the trainee performance and thus effectiveness of simulator training. An overview of the methods presently used is given hereafter:

- Checklists: One of the most common methods used in the assessment or evaluation of practical training.
- Plots and print-outs: Either independently or together with checklists or other means, a commonly used method for evaluating student performance on a (bridge) simulator is by means of a plot of the sailed track or a printout of any relevant parameters monitored during the exercise.
- Examiner evaluation: The easiest method by far is observing of the trainee by the instructor/examiner who then mentally sets an evaluation to the performance.

3.4. COMPETENCES THAT CAN BE ASSESSED BY SIMULATOR

Having identified the main aspects in application of maritime simulation for the training and assessment of seafarers, it is now of interest to make the inventory of which competences can be demonstrated by approved simulator training, according to STCW 95/2010 code Part A competence tables. Nevertheless within the scope of this research it has been explicitly agreed that only the competences relating to the deck department are taken into consideration.

The STCW function Group in Chapter II are as follows:

- Navigation
- Cargohandling
- Controlling ship operations
- Maintenance and repair

A total of 26 competences evaluable with simulator, but not all knowledge of each of these competences is entirely evaluable by simulator. Considering both levels (operational and management):

- There are a total of 19 competences for the operational level, and 11 of them may be evaluated by simulator; that is the 57.9%. More specifically: the Navigation section (operational level) consists of 9 competences, and 8 of them may be evaluated by simulator, representing the 88.9%; the Cargo handling and stowage section (operational level) consists of 2 competences, both evaluated by simulation, that is, the 100%, and the Controlling the operation of the ship care for persons on board section (operational level) has 8 competences, but only 1 may be assessed by simulator, that is the 12.5%.
- There are a total of 20 competences for the management level, and 15 of them may be evaluated by simulator; that is the 75%. More specifically: the Navigation section (management level) consists of 11 competences, and 9 of them may be evaluated by simulator, representing the 81.8%; the Cargo handling and stowage section (management level) consists of 3 competences, all of them evaluable by simulation, that is, the 100%, and the Controlling the operation of the ship care for persons on board section (operational level) has 6 competences, and 3 may be assessed by simulator, that is the 50%.

The legal basis for evaluating only with simulator is found in column 3 of the tables provided (see figure 5), where it says that for all these cases: *Examination and assessment of evidence obtained from one or more of the following competences: (...)*. In all cases, one of the modalities is: *approved simulator training, where appropriate*.

Figure 5 - Table A-II/1 of the STCW Code

Table A-II/1
Specification of minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more

Function: Navigation at the operational level

Column 1	Column 2	Column 3	Column 4
Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Plan and conduct a passage and determine position	<p><i>Celestial navigation</i></p> <p>Ability to use celestial bodies to determine the ship's position</p> <p><i>Terrestrial and coastal navigation</i></p> <p>Ability to determine the ship's position by use of:</p> <p>.1 landmarks</p> <p>.2 aids to navigation, including lighthouses, beacons and buoys</p> <p>.3 dead reckoning, taking into account winds, tides, currents and estimated speed</p>	<p>Examination and assessment of evidence obtained from one or more of the following:</p> <p>.1 approved in-service experience</p> <p>.2 approved training ship experience</p> <p>.3 approved simulator training, where appropriate</p> <p>.4 approved laboratory equipment training</p> <p>using chart catalogues, charts, nautical publications, radio navigational warnings, sextant, azimuth mirror, electronic navigation</p>	<p>The information obtained from nautical charts and publications is relevant, interpreted correctly and properly applied. All potential navigational hazards are accurately identified</p> <p>The primary method of fixing the ship's position is the most appropriate to the prevailing circumstances and conditions</p> <p>The position is determined within the limits of acceptable instrument/system errors</p> <p>The reliability of the information obtained from the primary method of position fixing is checked at appropriate intervals</p> <p>Calculations and measurements of navigational information are accurate</p>

source: International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, STCW 1978 as amended in 1995/2010

4. DESIGN OF THE REVALIDATION MODEL COURSES

Including all competences evaluable with simulator obtained in the above section, we designed two model courses: one for the operational level and one for the management. The aim of these courses is to provide training in a typical preparation and use of simulation material.

4.1. IMO MODEL COURSES

In order to give assistance to those starting out using simulators in their training programmes a number of model menus have been developed as guidance for such implementation.

IMO, through contributions and sponsoring governments has invested heavily in the further improvement of maritime training and education programmes. The well-known World Maritime University (WMU), being a prominent example was established in 1983 under the philosophy that it would be more effective to bring the developing world to the experts, than sending the experts to the developing world.

Once graduated from WMU the newly trained teachers and instructors upon returning to their countries are often faced with a lack of teaching programmes and materials. For this purpose standard menus to conduct courses in numerous maritime subjects have been developed in the form of the so-called IMO Model Courses [4].

These revalidation model courses have been developed following the model course structure adopted by the International Maritime Organization (IMO).

4.2. STRUCTURE OF THE REVALIDATION MODEL COURSE

First stage implied determining the knowledge required for each of the 26 competences and the type of simulator to be used. If a knowledge aspect is evaluable by using additional material apart from the simulator, this is indicated as Supporting Material (SM) and in other cases, “it depends on the simulator”.

It is observed that many skills/knowledge areas may be explained and evaluated in a single exercise. For example, the use of navigational equipment, such as radar, ARPA, steering control systems or ECDIS, can be assessed at the same time that the watchkeeping procedures. Therefore, for each level (operational and management), it is possible to do some long exercises for training; simulating. Each model course is divided considering 7 sections or exercises. The first section comprises a familiarization with simulators and the other six include different kinds of exercises.

1. Familiarization
2. Planning a voyage
3. Watchkeeping
4. Manoeuvring

5. Cargo handling for different kinds of ships
6. Emergencies and rescue
7. Controlling the operations of the ship and care on board

For evaluating the trainee, these exercises should be shorter, and he should select one from each group. Moreover, a familiarization with the simulation tools is also necessary for the trainee (same for the operational and management courses).

Planning voyage and watchkeeping exercises are single but long exercises; manoeuvring exercises depend on whether the ship berths, unberths, anchors, etc., and the cargo handling exercises also depend on the kind of cargo/type of ship. The Emergencies and rescue group consists of some skills/knowledge areas that need one or more exercises for each area. Finally, controlling operations of ship and care on board group is only for the operational level and consists of a reduced number of exercises.

Another important point involves elaborating all supporting materials (SM), and finally, determining the time required for explaining and evaluating all skills/knowledge points.

Hereunder (see Table 2 and Table 3) it is attached a table of the competences evaluable in each group and the kind of simulator.

Table 2 - Main Structure of the course considering competences to be evaluated in operational level and Simulation Type of Support Material (SM) to be used

Exercise	Competences for the Operational level
1. Familiarization	
2. Planning a voyage	Competence 1.b: Terrestrial and coastal navigation: Thorough knowledge of and ability to use nautical charts, such as sailing directions, tide tables, notices to mariners, radio navigational warnings and ship's routing information. SM & NAV or NAV/RAD Competence 2.c: The use of routing in accordance with the General Provisions on Ship's Routing. SM
3. Watchkeeping	Competence 1. Celestial Navigation; Terrestrial and coastal navigation; Electronic systems of position fixing and navigation; Echo-sounders; Compass – magnetic and gyro; Steering control system; Meteorology. SM & NAV or NAV/RAD Competence 2. Thorough knowledge of the content of the International Regulations for Preventing Collisions at Sea, 1972, as amended; Thorough knowledge of the content of the International Regulations for Preventing Collisions at Sea, 1972, as amended; The use of information from navigational equipment for maintaining a safe navigational watch; Knowledge of blind pilotage techniques; The use of reporting of accordance with the General Principles for Ship Reporting Systems and the VTS procedures; Knowledge of bridge resource management principles. SM & NAV, NAV/RAD, COM and VTS Competence 3. Knowledge of the fundamentals of radar and automatic

Exercise	Competences for the Operational level
	<p>radar plotting aids; Ability to operate and to interpret and analyse information obtained from radar; Principal types of ARPA, their display characteristics, performance standards and the dangers of over-reliance on ARPA; Ability to operate, interpret and analyse information obtained from ARPA. SM & NAV or NAV/RAD with ARPA application.</p> <p>Competence 4. Knowledge of the capability and limitations of ECDIS operations; Proficiency in operation, interpretation, and analysis of information obtained from ECDIS. SM & NAV or NAV/RAD with ECDIS application.</p>
4. Manoeuvring	<p>Competence 8. The effect of deadweight, draught, trim, speed and under-keel clearance on turning circles and stopping distances; The effects of wind and current on ship handling; Maneuvers and procedures for rescuing a person overboard; Squat, shallow-water and similar effects; Proper procedures for anchoring and mooring. SM & NAV.</p>
5. Cargo handling	<p>Competence 9. Knowledge of the effect of cargo, including heavy lifts, on the seaworthiness and stability of the ship; Knowledge of safe handling, stowage and securing of cargoes, including dangerous cargoes, hazardous and harmful cargoes, and their effect on the safety of life and the ship; Ability to establish and maintain effective communications during loading and unloading. SM & CAR, CRA and COM.</p> <p>Competence 10. Inspect and report defects and damage to cargo spaces, hatch covers and ballast tanks. It depends on the simulator, with SM during the briefing.</p>
6. Emergencies and rescue	<p>Competence 5. Emergency procedures. SM & SPI, CAR and/or BAL where appropriate and SAR.</p> <p>Competence 6. Search and rescue. Knowledge of the contents of the International Aeronautical and Maritime Search and Rescue (IAMSAR) Manual. SAR and COM where appropriate.</p> <p>Competence 7. Visual signaling. SM & and COM where appropriate.</p>
7. Controlling the operations	<p>Competence 11. Ship stability; Ship construction. SM, CAR and BAL</p>

Table 3 - Main Structure of the course considering competences to be evaluated in management level and Simulation Type of Support Material (SM) to be used

Exercise	Competences for the Management level
1. Familiarization	
2. Planning a voyage	Competence 12. Plan a voyage and conduct navigation. SM & NAV with ECDIS application and VTS Competence 18. Maintain the safety of navigation through the use of ECDIS and associated navigations system to assist in command decisions making. NAV/RAD with ECDIS application
3. Watchkeeping	Competence 13. Determine position and the accuracy of resultant position fix by any means. SM & NAV with ECDIS application Competence 14. Determine and allow for compass errors. SM & NAV Competence 16. Establish watchkeeping arrangements and procedure. SM & NAV Competence 17. Maintain safe navigation through the use of information from navigation equipment and systems to assist in command decision making. SM & NAV/RAD with ARPA application and COM
4. Manoeuvring	Competence 19. Manoeuvre and handle a ship in all conditions. SM & NAV, COM, SHIP and VTS. Competence 20. Operate remote controls of propulsion plant and engineering systems and services. SM & SHIP, CAR and BAL
5. Cargo handling	Competence 21. Plan and ensure safe loading, stowage, securing, care during the voyage and unloading of cargoes. SM & SHIP, CAR, BAL and COM Competence 22. Assess reported defects and damage to cargo spaces, hatch covers and ballast tanks and take appropriate action. SM & a simulation depending on the simulator. Competence 23 Carriage of dangerous goods. SM & a simulation depending on the simulator.
6. Emergencies and rescue	Competence 15. Coordinate search and rescue operations. SM & NAV, SAR and COM.
7. Controlling the operations	Competence 24. Control trim, stability and stress. SM & CAR and BAL Competence 25. Monitor and control compliance with legislative requirements and measures to ensure safety of life at sea, security and the protection of the marine environment. SM Competence 26. Use of leadership and managerial skill. SM with any simulator.

Both courses are 43-hour course allocated in the following manner (see Table 4 and 5). The duration allocated to each topic is presented in the Course Timetable of the model courses.

Table 4 - Distribution of the total number of hours of the operation level revalidation model course

Familiarization with simulators	Briefings, debriefings and no-simulation explanations	Simulation trainings	Evaluation in simulators	Evaluation with theoretical exam
2.0 h	16.0 h	22.0 h	2.0 h	1.0 h

Table 5 - Distribution of the total number of hours of management level revalidation model course

Familiarization with simulators	Briefings, debriefings and no-simulation explanations	Simulation trainings	Evaluation in simulators	Evaluation with theoretical exam
2.0 h	19.5 h	18.5 h	2.0 h	1.0 h

Each model course has been designed following the main parts of IMO model courses:

- Part A. Course Framework
- Part B. Course Outline and Timetable
- Part C. Detailed Teaching Syllabus
- Part E. Instructor Manual
- Part D. Evaluation and Assessment

5. CONCLUSIONS

A simulator is a tool in a learning process so the requirement to measure the effect of the use of that tool in reaching the learning objective is as valid as with any other tool. However in the case of assessment of simulation training the developments have been limited. This can be seen as partly due to the complexity of the training exercises, partly due to the difficulty of agreeing on acceptable standards.

From the results obtained in section 1, it can be drawn that the majority of countries started implementation of CoC revalidation programs for the training of marine officers using simulators. However, answers vary considerably, so the development of a simulation model course for revalidation of CoC will provide the required education level and homogenise the approaches of different countries concerning revalidation programs in accordance with the provisions of STCW Code for existing marines who need upgrade their professional maritime. This course will provide training in a typical preparation and use of simulation material.

Once the revalidation simulation-based model course is designed, a course book with schedules, simulator lessons and competences to train on simulation is delivered.

Some of the competences necessary by the revalidate student are not assessable on simulator, so apart from this course book, some extra courses evaluating other competences should be designed before a student obtains his/her CoC. It must be noted that for obtaining a revalidated CoC, the student should attend additional courses to this revalidation model course (for instance, basic safety, medical first aid and advanced firefighting), so further research will be necessary.

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